THE UNIVERSITY OF AUCKLAND

SUMMER SCHOOL 2020

Campus: City

COMPUTER SCIENCE

Introduction to Computer Systems

(Time Allowed: TWO hours)

Note:

- Your Teleform sheet is stapled at the end of this question/answer book. Remove the Teleform sheet from the question/answer book.
- The version code for this question/answer book is **00003881**. You MUST carefully check that this version code corresponds to the one on the Teleform. If the version codes do not match, please inform the exam supervisor IMMEDIATELY.
- Enter your name and student ID on the Teleform sheet. You must also enter your name and student ID on this question/answer book in the space provided below.
- Enter your answers on the Teleform. Answers entered in the question/answer book will not be marked.
- At the end of the exam, submit the Teleform only. You MUST retain this question/answer book until the marking is complete and you have received the mark or grade for this assessment.
- Each of the 45 questions is expected to have exactly 1 (one) correct answer. If you believe that a question has either NO or MULTIPLE correct answers, select the ONE you believe is most likely to be the intended answer.
- All questions carry equal marks. You must answer 40 out of the 45 questions correctly in order to obtain full marks in this exam. Any excess marks may be used to offset marks lost in the mid-semester test.
- This exam counts for 50% of your final grade.

Name: .....

ID: .....

1. Which of the following strings, when compressed with the RLE algorithm discussed in class, will result in a compression ratio of 1.5 or more?

   X. fffFFFaabb
   Y. Roland
   Z. oooohhhh

   A. X and Y only
   B. X and Z only
   C. Y and Z only
   D. All of X, Y, and Z
   E. None, or only one of X, Y, and Z

2. Which of the following additions are **CORRECT**? Note the subscripts denote the bases (8=octal, 16=hexadecimal).

   X. $2552_8 + 366_8 = 3140_8$
   Y. $C43_{16} + D1_{16} = D14_{16}$
   Z. $4252_8 + 365_8 = 4640_8$

   A. X and Y only
   B. X and Z only
   C. Y and Z only
   D. All of X, Y, and Z
   E. None, or only one of X, Y, and Z

3. Which of the following subtractions are **CORRECT**? Note the subscripts denote the bases (8=octal, 16=hexadecimal).

   X. $2403_8 - 55_8 = 2326_8$
   Y. $2643_8 - 320_8 = 2321_8$
   Z. $EBB_{16} - 21_{16} = E9A_{16}$

   A. X and Y only
   B. X and Z only
   C. Y and Z only
   D. All of X, Y, and Z
   E. None, or only one of X, Y, and Z

4. Which of the following answers correctly give the 8-bit two's complement of the specified decimal number?

   X. 99 is 0110 0011
   Y. -83 is 1101 0011
   Z. -126 is 1000 0001

   A. X only
   B. Y only
   C. Z only
   D. None of X, Y, and Z
   E. All, or two of X, Y, and Z

5. Which of the following are correct representations of the specified decimal values in the 16-bit floating point format presented in lectures and the textbook? Note that the floating point representation has been expressed in hexadecimal.

   X. -207.5 (decimal) is E7C8 (hexadecimal).
   Y. 1024 (decimal) is 400B (hexadecimal).
   Z. -55.375 (decimal) is EEC6 (hexadecimal).

   A. X only
   B. Y only
   C. Z only
   D. None of X, Y, and Z
   E. All, or two of X, Y, and Z

6. Given that the hexadecimal value of the ASCII code for "A" is 41, the ASCII code for "a" is 61 and the ASCII code for "1"(one) is 31, which of the following statements are TRUE? All numbers are in hexadecimal.

   X. The ASCII code for "L" is 52.
   Y. The ASCII code for "m" is 6D.
   Z. The difference between the ASCII encoding for all lowercase letters and their uppercase equivalents is decimal 20.

   A. X only
   B. Y only
   C. Z only
   D. None of X, Y, and Z
   E. All, or two of X, Y, and Z

7. Consider the truth table below:

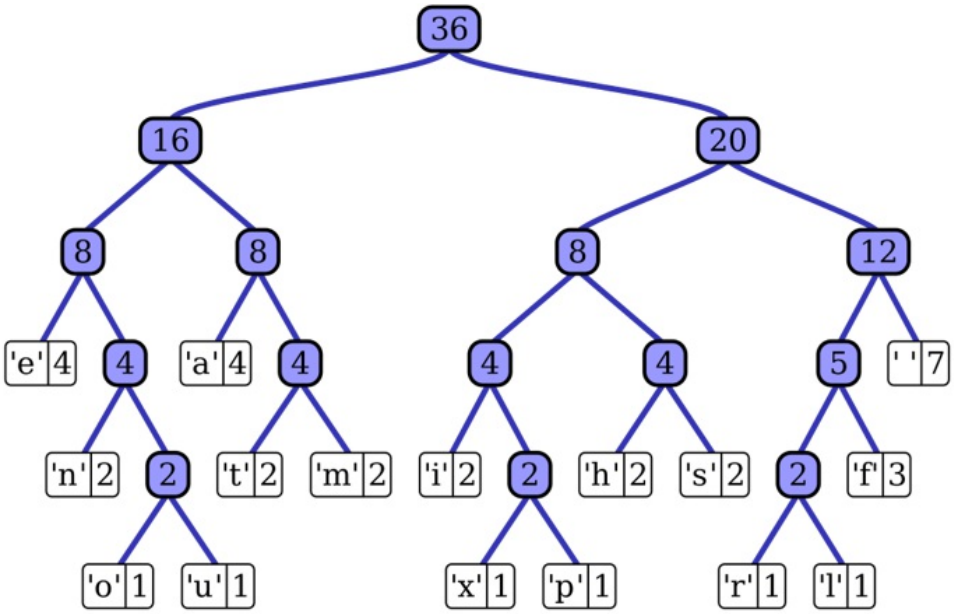
A	B	C	Output
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

   Which of the following boolean expressions match the output column in the truth table above?

   X. (NOT A AND B AND C) OR (A AND NOT B AND NOT C)
   Y. (NOT A AND NOT B AND NOT C) OR (A AND B AND NOT C)
   Z. (NOT A AND NOT B AND NOT C) OR NOT (NOT A OR NOT B OR C)

   A. X and Y only
   B. X and Z only
   C. Y and Z only
   D. All of X, Y, and Z
   E. None, or only one of X, Y, and Z

8. Consider the Huffman tree below:



Which of the following statments about this Huffman tree are TRUE?

X. The Huffman code for 'h' is 0101.
Y. The Huffman code for 'a' is 100.
Z. The Huffman code for 'u' is 00111.

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

9. Which of the following statements are **TRUE**?

X. The instruction register holds the encoding of the next instruction.
Y. The textbook architecture uses byte addressing.
Z. The program counter register holds the address of the next instruction.

A. X and Y only
B. X and Z only
C. Y and Z only
D. All of X, Y, and Z
E. None, or only one of X, Y, and Z

10. Here is a program using the pseudocode presented in lectures:

```
get number
first ← 1
second ← 1
value ← 0
if number <= 2 then
    value ← 1
else
    count ← 3
    while count <= number
        value ← first + first + second
        first ← second
        second ← value
        count ← count + 1
    end while
end if
print value ↵
```

Using this program, which of the following give the correct output with the given input?

X. Input: 4, Output: 5
Y. Input: 6, Output: 21
Z. Input: 1, Output: 0

A. X and Y only
B. X and Z only
C. Y and Z only
D. All of X, Y, and Z
E. None, or only one of X, Y, and Z

11. Here is an assembly language program using the textbook language (the appendix contains the textbook instruction set):

```
        .BEGIN
        IN X
L:      LOAD X
        COMPARE Z
        JUMPEQ E
        LOAD W
        ADD Y
        STORE W
        INCREMENT Y
        DECREMENT X
        JUMP L
E:      OUT W
        HALT
W:      .DATA 0
X:      .DATA 0
Y:      .DATA 1
Z:      .DATA 0
        .END
```

Using this program which of the following give the correct output with the given input?

X. Input: 5, Output: 15
Y. Input: 2, Output: 2
Z. Input: 4, Output: 4

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

12. Here is an assembly language program using the textbook language. The comments at the right end of each line are for numbering the lines. The program starts at address zero. The appendix contains the textbook instruction set.

```
      .BEGIN        -- line 1
      IN X          -- line 2
L:    LOAD X        -- line 3
      ADD X         -- line 4
      STORE X       -- line 5
      LOAD Z        -- line 6
      COMPARE Y     -- line 7
      JUMPEQ E      -- line 8
      DECREMENT Z   -- line 9
      JUMP L        -- line 10
E:    OUT X         -- line 11
      HALT          -- line 12
X:    .DATA 0       -- line 13
Y:    .DATA 0       -- line 14
Z:    .DATA 3       -- line 15
      .END          -- line 16
```

Using this program, which of the following have the correct machine code and data (both in hexadecimal) for the specified line?

X. Line 3 - 000D
Y. Line 7 - 700E
Z. Line 4 - 300D

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

13. Consider the following C or Java source code:

```
while (j != k) { j = (k0+k1) / f3;}
```

If analysed with the lexicographical analyser from the lectures, how many tokens and token classes do we find here?

A. 19 tokens and 12 token classes
B. 18 tokens and 11 token classes
C. 19 tokens and 11 token classes
D. 18 tokens and 9 token classes
E. 18 tokens and 10 token classes

14. Which of the following BNF specifications are recursive?

X. <hostname> ::= <ialpha>|<ialpha>.<hostname>
Y. <hostnumber> ::= <digits>.<digits>.<digits>.<digits>
Z. <sum> ::= <sum> + <term> | <term>

A. X and Y only
B. X and Z only
C. Y and Z only
D. All of X, Y, and Z
E. None, or only one of X, Y, and Z

15. Consider the following BNF grammar:

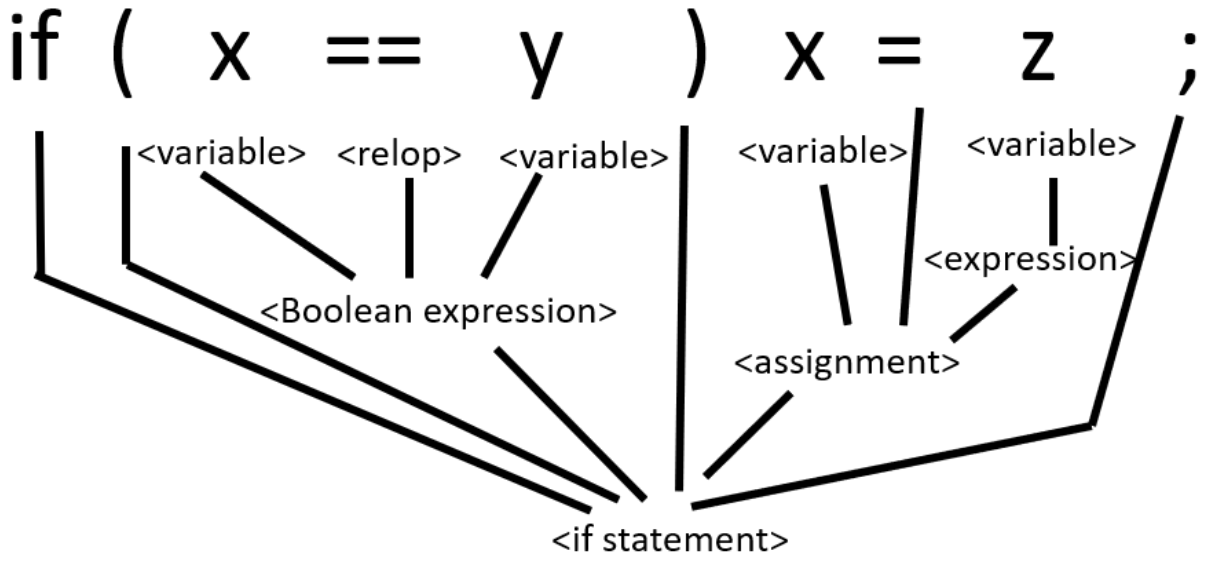
```
<nonzerodigit> ::= 1|2|3|4|5|6|7|8|9
<digit> ::= 0|<nonzerodigit>
<number> ::= +<nonzerodigit><digit>|<nonzerodigit><digit>
```

Which of the following patterns does this grammar match?

X. 33
Y. 91
Z. +40

A. X and Y only
B. X and Z only
C. Y and Z only
D. All of X, Y, and Z
E. None, or only one of X, Y, and Z

16. Consider the parsing tree below:



Which of the following BNF grammar definitions could have been involved in the production of this tree?

X. <variable> ::= <term>
Y. <variable> ::= x|y|z
Z. <relop> ::= ==|<|>

A. X and Y only
B. X and Z only
C. Y and Z only
D. All of X, Y, and Z
E. None, or only one of X, Y, and Z

17. Which of the following statements are true about semantic analysis during compilation?

X. If a semantic record relates to an expression it stores a temporary name for the expression.
Y. A syntactically correct statement is not examined during the semantic analysis phase.
Z. A new semantic record must be created for each non-terminal symbol in the parse tree.

A. X and Y only
B. X and Z only
C. Y and Z only
D. All of X, Y, and Z
E. None, or only one of X, Y, and Z

18. Assume that in a multiprocess OS, each process spends about 50% of it's time waiting for I/O operations to be completed. Which of the following statements are true?

X. A multiprocess OS does not improves processor utilization since it involves too much context switching.
Y. If there are 2 processes loaded into memory, the processor utilization will be 75%.
Z. If there are 3 processes loaded into memory, the processor utilization will be more than 80%.

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

19. A file on a Linux machine has permissions `rw-r--r--`. This file is:

    X. executable by its owner.
    Y. not readable by members of its group.
    Z. not writable by its owner.

    A. X only
    B. Y only
    C. Z only
    D. None of X, Y, and Z
    E. All, or two of X, Y, and Z

20. A file on a Linux machine should have permissions `rw-r-----`. Which command do you use to set these permissions?

    A. chown 640
    B. chperm 644
    C. chmod 644
    D. chmod 640
    E. chmod 666

21. Which of the following statements about file permissions in Unix are correct?

    X. If a directory has read permissions set, all files in the directory must have the same read permissions.
    Y. Changing file ownership requires root privileges in all cases.
    Z. A directory with execute permissions for "others" allows anyone with an account to `cd` into it.

    A. X and Y only
    B. X and Z only
    C. Y and Z only
    D. All of X, Y, and Z
    E. None, or only one of X, Y, and Z

22. Which of the following situations are deadlocked or might create one?

X. A system has six units of a resource, with 6 processes competing for them. Each process needs two units.
Y. Process B is waiting for data from process C. Process C is waiting for A to finish writing to file X that A has locked. Process A is waiting for Process B to release a lock on file Y.
Z. There are 3 processes each requiring 3 units of a resource R. The system has 5 units of R.

A. X and Y only
B. X and Z only
C. Y and Z only
D. All of X, Y, and Z
E. None, or only one of X, Y, and Z

23. Which of the following features are **essential** in a multi-user operating system?

X. A graphical user interface
Y. File encryption on disk
Z. Two factor authentication

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

24. Which of the following statements are true about malware?

X. The most common mechanism for spreading a virus is through email attachments.
Y. Installing regular updates to an operating system is not good since it lowers the processor efficiency.
Z. A Trojan horse can hide a keystroke logger that captures user's passwords.

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

25. Consider a ciphertext QZIY. If you know that this was encrypted with a Caesar cipher from plaintext IRAQ, which of the following could be the key? You may assume that the cipher's alphabet consists of the 26 letters of the English alphabet only.

A. 21
B. 8
C. 16
D. 20
E. 12

26. Consider the plaintext PUMPKIN. If encrypted with a Caesar cipher with key 10, which of the following is the ciphertext? You may assume that the cipher's alphabet consists of the 26 letters of the English alphabet only.

    A. ZEWZUHM
    B. ZEWZIGL
    C. ZEWZUSN
    D. ZEWMHFK
    E. ZEWZUSX

27. Decrypt the ciphertext `WSNXSQRD`:

    A. LIFETIME
    B. ACCURACY
    C. COMMERCE
    D. MIDNIGHT
    E. ACCEPTED

28. Consider the plaintext CFG over the shortened alphabet A=0, B=1, C=2, D=3, E=4, F=5, G=6, H=7. What is the ciphertext if we encrypted the plaintext with the following block cipher key:

$$\begin{bmatrix} 7 & 5 & 1 \\ 1 & 0 & 2 \\ 4 & 1 & 7 \end{bmatrix}$$

    Note: Given the size of the alphabet, you will need to use `mod 8`.

    A. EAA
    B. EFC
    C. GAC
    D. AGE
    E. DAG

29. Which of the following are **TRUE** with respect to RSA?

X. The public key is used to encrypt messages intended for parties other than the owner.
Y. The second part of the public key can be computed once the first part is known.
Z. The private key is used to encrypt messages intended for the owner only.

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

30. Which of the following are **TRUE**?

X. A 1500 byte frame on a 100 Mbps Ethernet takes the same time to travel from one end of an Ethernet segment to the other as on Gigabit Ethernet.
Y. Ethernet switches increase available network bandwidth in a LAN.
Z. Gigabit Ethernet is ideal for international networks linking countries across oceans since fiber is costly.

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

31. Which of the following are **TRUE**?

X. Internet connections via geostationary satellite suffer from high latency.
Y. Geostationary satellite ground stations need larger antennas than medium earth orbit satellite ground stations.
Z. A geostationary satellite can provide service to the same ground station around the clock.

A. X and Y only
B. X and Z only
C. Y and Z only
D. All of X, Y, and Z
E. None, or only one of X, Y, and Z

32. Which of the following are **TRUE** in terms of the maximum achievable bit rate between two hosts connected by this technology?

    X. Gigabit Ethernet has a higher bit rate than Fibre.
    Y. VDSL has a higher bit rate than 100 Mbps Ethernet.
    Z. ADSL has a higher bit rate than Fibre for small distances.

    A. X only
    B. Y only
    C. Z only
    D. None of X, Y, and Z
    E. All, or two of X, Y, and Z

33. Which of the following statements are **TRUE** with respect to packet size on a network shared with other hosts?

    X. Making packet size smaller may mean having to send more header bytes for the same amount of payload data.
    Y. The larger we make our packet size, the longer other hosts may have to wait until they can transmit.
    Z. Larger packet sizes increase the bit rate on the network.

    A. X and Y only
    B. X and Z only
    C. Y and Z only
    D. All of X, Y, and Z
    E. None, or only one of X, Y, and Z

34. With reference to the OSI layer model, the

    A. session layer interacts with the network layer above and the physical layer below.
    B. session layer interacts with the presentation layer above and the transport layer below.
    C. session layer interacts with the physical layer above and the application layer below.
    D. session layer interacts with the physical layer above and the network layer below.
    E. session layer interacts with the transport layer above and the network layer below.

35. Which of the following are **TRUE** with respect to a TCP-based data communication between two IP hosts on the Internet?

X. Routers along the way use the TCP destination port numbers to determine the correct outgoing interface.
Y. The Ethernet headers of packets passing through a switch remain unchanged.
Z. The transport layer forwards packets from one router to the next.

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

36. Which of the following are valid sets of instructions for a Turing machine?

X. (1,0,0,2,L),(1,1,0,4,L),(2,0,1,3,L),(3,0,0,1,L),(3,1,0,1,L)
Y. (1,b,0,2,R),(1,1,0,3,R),(2,b,1,1,R),(3,0,0,1,R),(3,0,0,1,L)
Z. (1,0,0,1,L),(1,b,0,2,L),(1,b,0,1,L),(2,0,1,1,R),(2,1,0,1,R),(2,b,0,1,L)

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

37. Consider the following sets of instructions, some of which may not be valid. Which of the sets are valid **and** prevent a Turing machine from halting irrespective of the input to the machine on the tape? You may assume that the machine is in state 1 at the start of execution.

X. (1,0,1,2,R),(1,1,0,2,R),(1,b,1,1,L),(2,0,1,3,R),(2,b,1,1,R),(3,0,1,2,L),(3,1,b,3,R),(3,b,1,2,L)
Y. (1,0,0,2,L),(1,1,0,2,L),(1,b,b,2,R),(2,0,1,2,L),(2,1,1,1,R),(2,b,0,2,R)
Z. (1,0,1,2,L),(1,1,0,2,R),(1,b,0,1,L),(2,0,1,1,R),(2,1,1,2,R),(3,0,1,2,R),(3,1,b,3,L),(3,b,1,2,R)

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

38. Consider the following instruction set for a Turing machine:

```
(1,0,0,2,R)
(1,1,0,4,R)
(2,0,0,4,R)
(2,1,0,3,R)
(3,0,0,5,R)
(3,1,0,1,R)
(4,0,1,2,R)
(4,1,1,4,R)
(5,0,1,2,R)
(5,1,0,5,R)
```

If the Turing machine is run on the tape `101010...`, starting in state 1 on the first symbol on left of the tape, which state does it end up in after executing 6 instructions?

A. State 1
B. State 5
C. State 4
D. State 2
E. State 3

39. Consider the following instruction set for a Turing machine:

```
(1,0,1,2,R)
(1,1,0,4,R)
(2,0,1,5,R)
(2,1,1,3,R)
(3,0,0,5,R)
(3,1,0,1,R)
(4,0,1,2,R)
(4,1,1,4,R)
(5,0,1,2,R)
(5,1,1,4,R)
```

If the Turing machine is run on the tape `010111...`, starting in state 1 on the first symbol on the left of the tape, what is written on the tape after 6 instructions have been executed?

A. ...100111...
B. ...110011...
C. ...110111...
D. ...111111...
E. ...010111...

40. Which of the following statements on Turing machines are **TRUE**?

X. There is exactly one Turing machine for every computable problem.
Y. A Turing machine that does not halt is not a Turing machine.
Z. Turing machines can be used to show that the halting problem is unsolvable.

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

41. Which of the following are reasoning tasks?

X. Understanding the spoken word.
Y. Ranking products based on sales.
Z. Managing a payroll.

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

42. Which of the following statements about back propagation in neural networks is **TRUE**?

X. If an output neuron fired erroneously, its negative (inhibitory) weights are increased.
Y. In back propagation, the weights from each neuron layer are moved to the previous layer.
Z. If an output neuron failed to fire, its firing threshold is decreased.

A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

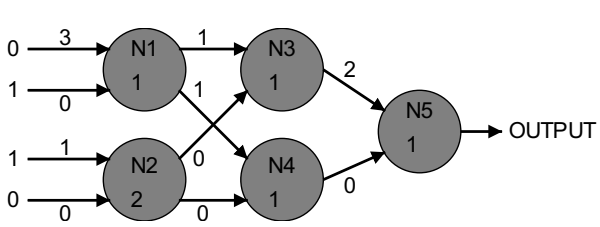
43. Which of the following statements on robots are **TRUE**?

X. Every robot must have a complete knowledge representation about its environment.
Y. Robots can only be used for tasks where they cannot possibly make a mistake.
Z. All robots use sensors to detect what is around them.

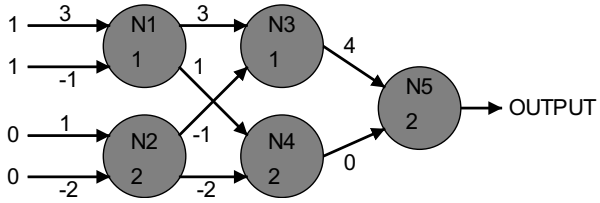
A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

44. Consider the following neural networks. Which networks output 1?

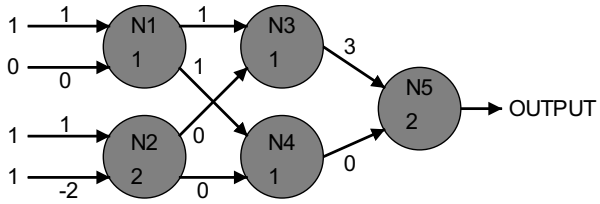
X.



Y.



Z.



A. X and Y only
B. X and Z only
C. Y and Z only
D. All of X, Y, and Z
E. None, or only one of X, Y, and Z

45. Which of the following sentences could be used as a Winograd schema?

X. Susan knows all about Ann's personal problems because she is nosy.
Y. If the con artist had succeeded in fooling Sam, he would have gotten a lot of money.
Z. The dog chased the cat when the owner was away.

A. X and Y only
B. X and Z only
C. Y and Z only
D. All of X, Y, and Z
E. None, or only one of X, Y, and Z

Appendix

FIGURE 6.5

Binary Op Code	Operation	Meaning
0000	LOAD X	CON(X) → R
0001	STORE X	R → CON(X)
0010	CLEAR X	0 → CON(X)
0011	ADD X	R + CON(X) → R
0100	INCREMENT X	CON(X) + 1 → CON(X)
0101	SUBTRACT X	R – CON(X) → R
0110	DECREMENT X	CON(X) – 1 → CON(X)
0111	COMPARE X	if CON(X) > R then GT = 1 else 0 if CON(X) = R then EQ = 1 else 0 if CON(X) < R then LT = 1 else 0
1000	JUMP X	Get the next instruction from memory location X.
1001	JUMPGT X	Get the next instruction from memory location X if GT = 1.
1010	JUMPEQ X	Get the next instruction from memory location X if EQ = 1.
1011	JUMPLT X	Get the next instruction from memory location X if LT = 1.
1100	JUMPNEQ X	Get the next instruction from memory location X if EQ = 0.
1101	IN X	Input an integer value from the standard input device and store into memory cell X.
1110	OUT X	Output, in decimal notation, the value stored in memory cell X.
1111	HALT	Stop program execution.

Typical assembly language instruction set